Late Quaternary erosion, deposition and soil formation near Grevena, Greece:- chronology, characteristics and causes

Mount Orlikos limestone ridge near the village of Zakais, Nomos of Grevena Greece

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Declaration

This thesis contains no material which has been accepted for a degree, diploma or any other higher degree by any other institution, except by way of background information and where duly acknowledged in the thesis and to the best of the my knowledge and belief, this thesis contains no material previously published or written by another person, except where due acknowledgement is made in the text.

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Abstract

A history of soil erosion, alluvial and colluvial deposition is presented for a small catchment in NW Greece. The role of climatic events, tectonics and human disturbance of the landscape are examined.

A major valley aggradation, named the Syndendron alluvium, was deposited in the valley floor during the close of the last glaciation. The 15,000 – 10,000 cal yr BP period was a time of dramatic climate fluctuations and associated changes in vegetation, fluctuating between steppe and oak woodland. The Syndendron alluvial deposit is associated with significant fires in the mid and upper catchment, as indicated by ash layers and charcoal in soils dated from this time. Regular fires were clearly an important part of landscape modification in sediments and soil deposited after about 15,000 cal yrs BP. The deposition of the Syndendron alluvium may have began as early as 14,200 cal yr BP but more likely was deposited between *ca* 12,250 and 9,300 cal yr BP (sites C11, C12, C13 and P37). The alluvium buries distinctive charcoal-rich paleosols dated between 14,700 and 14,200 cal yr BP (sites C6, C9 and C19). Debris flow deposits and slope wash from adjacent hill slopes provided the sediment source for the alluvium and slope wash has buried several distinctive late Pleistocene hill soils (sites C11, C12, C19). Alluvial sedimentation and hill slope erosion continued until at least 11,000 cal yrs BP, as indicated by an eroded hill soil at C11 that is buried by the aggrading Syndendron alluvium. Deposition had, however, ceased by *ca.* 9,300, as indicated by distinct alluvial soils that developed on the deposit (sites C12 and P37). Several colluvial soils dated to about 8,000 cal yr BP (C9 and C17) also cap the alluvium. The Syndendron alluvial event may in part relate to the arrival of humans during the climatic amelioration associated with the late glacial interstadial (Bolling-Allerod interstadials). Certainly there is increased burning of the catchment after about 15,000 cal yrs BP. Palaeolithic stone tools have been found in the catchment and along with others in the Grevena and Epirus regions, indicating humans were present. This period is also associated with colluvial soil deposition on lower slopes (sites C6 and C19). However, after about 12,250 cal yr BP there is a dramatic acceleration in the erosion rate and associated deposition on the

valley floor and lower slopes. While fire appears to be important, a change to drier and cooler conditions, recorded in the Greenland ice cores as the Younger Dryas phase, may have caused denudation between 12,800 and 11, 600 cal yrs BP. The climate change toward wetter conditions after 10,000 cal yr BP and increasing tree cover appears to have led to a more stable landscape indicated by soil development and associated soil creep. However, there have been no Mesolithic sites identified in Grevena, and it is generally a period of low human activity in Greece.

Following the hill slope erosion and deposition of the Syndendron alluvium the catchment seems to have become relatively stable as indicated by the development of moderately deep and well structured fertile black silty clay loam soils on the Syndendron alluvium. This is also supported in the upper catchment, as soil colluvium caps the Syndendron alluvium after 10,000 cal yr BP (site C12), and the stream re-incised the alluvium before 7,500 cal yr BP (site C11). The stream incision and also the arrival of Neolithic farmers in the valley are associated with a series of landslides and debris flow deposits between 7,500 and 6,500 cal yrs BP. In the lower catchment 2 m of fine-textured alluvium buries well-developed dark soils formed on the Syndendron alluvium sometime after 9,300 cal yrs BP. The landslide deposits dating between about 7,500 and 6,500 cal yr BP in the upper catchment contain large (4 x 1 m), intact pieces of highly weathered soil similar in chemical composition to those preserved on the upper slopes and catchment divide. The renewed incision of the Syndendron alluvium may have over-steepened some slopes and triggered land sliding at this time. The large size of the landslides and paucity of charcoal within them may implicate increased seismic activity as a trigger, as occurred during the 1995 Grevena earthquake. Fault displacements have been noted in both the Tertiary bedrock and the upper Plio-Pleistocene sediments within the catchment, although no active (Holocene) fault scarps were noted.

Work in the base of the catchment indicates that the Neolithic impact was generally minor, with 1.5 m of alluvial deposition occurring between 5,900 and about 4,700 cal yrs BP. However, this alluvium was then abruptly buried by over 2 m of slope deposits derived from erosion of adjacent hills at after about 4,400 cal yrs BP. Thin, 0.2m, A/C soils formed on the alluvial sediments during two stable periods each of about 500 years duration, indicating topsoils can develop rapidly in this environment.

Other dark, loamy soil-like colluvial materials begin to be transported down-slope at about 5,000 through to 2,750 cal yrs BP. However, between 2,200 and 1,300 cal yr BP dark greyish-brown calcareous colluvium containing bedrock debris was deposited in depressions and gullies. This hill slope erosion and deposition was associated with the latter phase of the Sirini alluvium, which is the second major Holocene alluvial valley fill. This alluvium is dated near its base to *ca.* 4,150 cal yrs BP, but the major deposition occurs after 3,100 cal yr BP with 5 m of sediment being deposited after this date. At another site more than 6 m of fine-textured alluvium is deposited after 2,450 cal yrs BP. Sheep/goat vertebrae and bovine teeth (male) were located in two of the alluvial sections and suggest agricultural grazing practises were very well established after about 3,100 cal yrs BP. The Sirini alluvial deposition continues until at least 2,000 cal yr BP as indicated at one site and 1,700 cal yr BP at another. The Sirini alluvial deposition coincides with a series of colluvial deposits on the valley sides dated between 2,750 and 1,390 cal yrs BP. This Sirini alluvial filling appears to be staggered. At one site a distinct alluvial soil separates the alluvium into two phases Sirini A and Sirini B. Re-incision of the Sirini alluvium occurred sometime after about 1,700 cal yrs BP. Thin and incipient A/C soils form on the top of this alluvium supporting its youthfulness.

In the modern valley floor a very young alluvial deposit named the Leipsokouki alluvium occurs 1 - 4 m above the modern flood plain. This alluvial fill has very weakly expressed topsoil development and is largely composed of raw weakly weathered alluvium. It is dated as modern (140 $\pm$ 130 cal yr BP Wk 9926) on charcoal taken from the upper fine-textured alluvium in the mid catchment, but elsewhere it contains Ottoman sherds.